

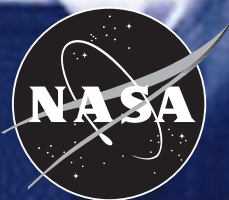
# Aerospace Technology INNOVATION

## NASA Education Programs Enlighten and Inspire

NASA Bridges the Gap

Aviation Gets a Lift

Campbell Named  
Laboratory  
Director  
of the Year



# INNOVATION

Aerospace Technology

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NASA strives for educational excellence in preparing our nation's next generation of leaders.

**On-Line Edition:** Go to <http://nctn.hq.nasa.gov> on the World Wide Web for current and past issues.

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## COMMERCIAL DEVELOPMENT MISSION UPDATE

Date*	Flight	Payload	Sponsor/Coordinator
7/99	STS-93 AXAF	AEROGEL Commercial Generic Bioprocessing Apparatus-04**	Marshall Space Flight Center BioServe Space Technologies

Note: Sortie flights beyond STS-95, and Space Station Operations, under review at this time.

\* As of April 1999.

\*\* In combination with National Institutes of Health payload NIH-B1 in support of Life Sciences Division requirements.

Key STS—Space Transportation System, AXAF—Advanced X-ray Astrophysics Facility (renamed Chandra X-ray Observatory)



# WELCOME TO INNOVATION

## NASA Committed to Educational Excellence

By Frank C. Owens

*Director, Education Division  
NASA Headquarters*

SINCE THE CREATION OF NASA IN 1958, THE space agency has made a substantial commitment and contribution to education. NASA Administrator Daniel S. Goldin has made both an agency and a personal commitment to education during his seven-year tenure. One of the contributions NASA makes to national priorities is: "Educational Excellence: We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds." Using this as guidance, the NASA Education Program uses its unique resources to support educational excellence for all.

In 1998, NASA involved more than 3 million students and educators through its Education Program. This comprehensive program has a strong presence in all 50 states, Puerto Rico and the District of Columbia, manifested through six broad programs. Teacher/Faculty Preparation and Enhancement uses the NASA mission and resources to provide exposure and access to NASA information to enhance educator knowledge and skills. The agency supports Systemic Improvement by supporting local, state, regional and national education change efforts through collaboration among educational organizations and agencies. Student Support is provided through research opportunities and experience supporting NASA missions. Through Educational Technology, NASA researches and develops technology education products and services to enhance education and lifelong learning. By using the resources and talents of the educational community—particularly the higher education community—Research and Development contributes to the development of new knowledge in support of the NASA mission. Finally, Curriculum Support and Dissemination develops, disseminates and uses curriculum support and instructional products (print and multimedia) for precollege and higher education.

There are numerous examples of specific NASA educational activities. Working to facilitate collaborations between education faculty and scientific and technical faculty, NASA helps develop innovative approaches to teacher preparation. Through the Summer High School

Apprenticeship Research Program, NASA provides opportunities for approximately 500 high school students to gain real-world research experience at NASA centers or other universities throughout the nation. The Mission Geography Project is a collaboration between NASA and the Geographic Education National Implementation Project (GENIP) to link geography education instructional materials to Earth science. The NASA Educator Resource Center Network (ERCN) is a network of sites located primarily at universities that are educator training facilities on NASA educational products. The NASA Space Grant Consortium consists of 700 university, state and local organizations providing state-based leadership in NASA research, education and public services. NASA also works to bring technology into the schools via the Learning Technologies Project (LTP), the Classroom of the Future (COTF) and EarthKAM.

NASA's four Strategic Enterprises are committed to educational excellence. The Earth Science Enterprise has implemented a program of total integration into agency programs. The Space Science Enterprise has focused on energizing the principal investigator community in support of education. The Human Exploration and Development of Space Enterprise is using the Space Shuttle and the International Space Station as unique platforms for education. The Aero-Space Technology Enterprise is developing programs and materials that enhance the teaching and learning of mathematics, science and technology.

In an effort to continually improve educational efforts, NASA continues to contribute to educational excellence, develop new alliances and "involve" the educational community. We are an agency with a unique mission, unique facilities and a very talented workforce. Over the next five years, we plan to continue using these unique assets and resources to improve our focus and coordination of state-based educational efforts, the quality and dissemination of our instructional products, the integration and coordination of our education programs and our support of preservice education. We also plan to implement a comprehensive system to collect data and feedback on our educational outreach efforts, to facilitate NASA research in the higher education community and to improve our level of involvement with the informal education community of museums, science and technology centers and other nonprofit educational organizations. As we continue to align our efforts as described herein, NASA can truly strive for educational excellence in preparing our nation's next generation of leaders. ✨

# TECHNOLOGY TRANSFER

## NASA Education Programs Enlighten and Inspire

**N**ASA'S EDUCATION VISION IS TO PROMOTE excellence in America's education systems for its basic product—the advancement of human knowledge. When Congress first established NASA 40 years ago, asking it to instruct and inspire, the Agency committed its mission and resources in supporting the teaching profession and increasing awareness of the impact that science, mathematics and technology will have on the quality of life in the 21st century.

NASA's national education programs are carried out through NASA Headquarters, its 10 field centers and a multifaceted network of partners, using educational resources that complement one another. The following highlights some of the curricula, programs, resources, alliances and opportunities for students, teachers and faculty through NASA's fellowships, scholarships, apprenticeships, workshops, classroom materials and interactive projects. Visit <http://www.spacelink.nasa.gov/Educational.Services> for a more extensive list of programs and information, including points of contact, admission criteria and financial support information.

### Teacher/Faculty Preparation and Enhancement

These programs are designed to provide opportunities for teachers and faculty to enhance knowledge and teaching skills through the use of NASA-related topics and research. *NASA Educational Workshops (NEW)* integrate national standards in math, science and technology. Participants are given an all-expenses-paid, two-week opportunity in the summer to observe NASA's state-of-the-art research and development through direct interaction with NASA scientists, engineers, technicians and educational specialists at each of the 10 NASA field centers. Techniques to integrate and translate information from this experience into the curriculum are a part of the workshops. Program collaborators with NASA are the National Science Teachers Association, the International Technology Educational Association and the National Council of Teachers of Mathematics. Visit <http://www.nsta.org/programs/new.htm>

The *NASA Opportunities for Visionary Academics (NOVA)* project provides faculty with enhanced knowledge and skills to create change in higher

education by creating a national preservice model based on science, math and technology literacy standards using the NASA mission, facilities and resources. Project NOVA encourages faculty to collaborate in developing innovative approaches to student learning that are not used in traditional content courses. Faculty and students also are encouraged to use the World Wide Web as an interactive technology utilization tool to exchange and have access to models, materials, activities and updated information. The process is sustained by mentoring workshop participants and collaborating with partner institutions. For more information, visit <http://www.eng.ua.edu/~nova>

Through *Summer Faculty Fellowships*, research fellowships are awarded to full-time engineering and science faculty members of U.S. colleges and universities—and some nonscience disciplines—for a 10-week research summer session. Fellows conduct research onsite, of mutual interest to them and the NASA research and development center. They are directly involved with a center colleague, the aeronautics and space program and accompanying basic research problems. Short courses, workshops and seminars are common features of the research programs. Families may join participants during the summer. Weekly \$1,000 stipends are awarded, and a travel allowance is paid, with relocation allowance possible where necessary. Visit <http://www.ASEE.org/fellowships>

### Curriculum Support and Dissemination

These programs provide *instructional materials* based on NASA's unique mission and resources in the areas of science, engineering, technology and mathematics. These materials are available to increase student interest, involvement and achievement.

The *NASA Central Operation of Resources for Educators (CORE)*, a national distribution network for hundreds of NASA's videocassette, slide and CD-ROM programs (including those designed for hearing-impaired students), provides teachers with access to NASA's multimedia educational tools. CORE also enables the educational community to access programs, materials and services of NASA's national



education program. For mail-order service, visit one of the NASA Educator Resource Centers located at NASA field centers and in selected museums, libraries, planetariums and universities throughout the United States, or contact Lorain County JVS, 15181 Route 58, South, Oberlin, Ohio 44074, 440/774-1051, ext. 235 or 249, fax 440/774-2144. View the catalog at <http://www.spacelink.nasa.gov/CORE>

The **Educator Resource Center Network (ERCN)**, with at least one center in every state, gives educators the opportunity to preview, copy and/or receive science, math and technology instructional products aligned with national and state frameworks and based on NASA's missions and results. Demonstrations of educational technologies, such as NASA Spacelink, NASA Television and the NASA

Education Home Page, are also provided to educators. Inservice and preservice training using NASA instructional products can also be provided. In addition, NASA has established several Regional Educator Resource Centers by forming partnerships with school systems, planetariums, museums and other nonprofit organizations. Visit <http://www.spacelink.nasa.gov/Educational.Services/NASA.Education.Programs/Curriculum.Support.and.Dissemination/Educator.Resource.Center.Network.-.ERCN/>

**NASA's On-line Resources for Educators** provide current educational information and instructional resource materials to teachers, faculty and students. A wide range of information is available, including science, math, engineering and technology education lesson plans, historical information related to the aeronautics and space program, current status reports on NASA projects, news releases, information on NASA educational programs, useful software and graphics files. Educators and students can also use NASA resources as learning tools to explore the Internet, accessing information about educational grants, interacting with other schools that are already on-line, participating in on-line interactive projects and communicating with NASA scientists, engineers, and other team members to experience the excitement of real NASA projects. Visit <http://www.hq.nasa.gov/education>



## Student Support

These programs provide enrichment experiences and financial support for students in research or industrial settings (for example, NASA centers, higher education institutions and industry) to foster careers in science, engineering, technology and mathematics. The **Graduate Student Researchers Program** invites university students to pioneer the nation's future in space and on Earth (within the framework of the NASA Strategic Plan). The competitive evaluation of proposals submitted nets nearly 160 new fellowship awards each year for graduate study, leading to research-based master's or doctoral degrees in the fields of science, mathematics and engineering. Fellowship grants of up to \$22,000 for one year and renewed up to three years, based on progress and available funding, are awarded to U.S. citizens enrolled as full-time graduate students in the nation's higher education institutions. Visit <http://www.ednet.gsfc.nasa.gov/gsrp/1999/solicitation/TOC.html>

## Research and Development

These programs use the talent and resources of the higher education community in NASA programs that contribute to the development of new knowledge in support of the NASA mission. **Experimental Program to Stimulate Competitive Research (EPSCoR)** develops academic research enterprises that are long term, self-sustaining and nationally competitive for non-EPSCoR dollars. Running in tandem with the NASA Space Grant College and Fellowship Program, EPSCoR targets states of modest research infrastructure with funds to develop a more competitive research base within their member academic institutions. EPSCoR projects are closely related to one of NASA's four Strategic Enterprises. EPSCoR researchers collaborate frequently with NASA field centers and program officers. EPSCoR fosters cooperation among departments, across institutions, with state and local governments and with business and industry.

EPSCoR awards encourage the participation of students, both graduate and undergraduate, in the funded research projects at NASA. EPSCoR awards require a one-to-one match from participating states and are guaranteed for three years with satisfactory performance, followed by a two-year renewal option after a comprehensive review. Other EPSCoR outcomes include the transfer of developed technology to industry, the increased economic development of the participating states and the communication of the benefits of research to the public. Visit <http://www.hq.nasa.gov/epscor>



*NASA Educator Resource Centers around the country help teachers and educators in incorporating technology into their classrooms and with curriculum development.*

NASA's *Space Grant College and Fellowship Program* emphasizes the diversity of human resources, the participation of students (elementary through secondary levels) in research and the communication of the benefits of science and technology to the public. This program provides NASA funding for space-related research, education and public service projects with business, industry and

departments among its national network of 52 university-based Space Grant Consortia. Since the program's inception by Congress in 1989, the Space Grant Consortia collectively have awarded more than 12,000 U.S. citizens with tuition assistance in science, engineering and related fields of study. Individual student awards have averaged \$2,000 for undergraduates and \$8,000 for graduate students. Remaining funds must be matched by other sources for research, the development or revision of research infrastructure and engineering and science curricula, as well as offer precollege activities to stimulate interest in science, mathematics and technology. Visit <http://www.hq.nasa.gov/spacegrant>

### Educational Technology

These programs use advanced technologies for education, including Internet services, CD-ROM databases, live or taped video, computer software, multimedia systems and virtual reality. This category also supports education technology research and development and the development of multimedia instructional resources, databases and dissemination systems.

The *NASA Education Home Page* serves as a cyber-gateway to information regarding educational programs and services offered by NASA, providing specific details and points of contact for all of NASA's program and projects. This site gives a comprehensive overview of NASA's educational programs and services, supplies specific details and points of contact and provides a searchable program inventory that has catalogued NASA's educational programs. Visit <http://education.nasa.gov>

*NASA Spacelink* is a "virtual library" search engine enabling educators to find information, regardless of its location within NASA. NASA educator guides, educational briefs, lithographs and other materials are cross-referenced throughout Spacelink with related topics and events. Special events, missions and intriguing web sites are featured in Spacelink's "Hot Topics" and "Cool Picks" areas, including *NASA...On the Cutting Edge*, a series of live and interactive education television programs. Broadcast via satellite to thousands of schools across the country, the series includes web chats, staff development for teachers, publications, curriculum support materials and occasional rebroadcasts of previous programs. Visit <http://www.spacelink.nasa.gov> ✨

For more information, visit <http://education.nasa.gov> Please mention that you read about it in *Innovation*.

## Launch Pad Coating Protects More Structures

**A** PROTECTIVE COATING USED FOR THE SPACE Shuttle and expendable launch vehicle (ELV) rocket engines is helping to protect a variety of structures, ranging from industrial plants to bridges to ships at sea. The coating, developed for NASA by Ameron International Corporation of Pasadena, California, to withstand the high temperatures generated by the Shuttle and ELV engines, is incorporated in some general-purpose formulations for the company's commercial customers.

A line of products formulated from this technology, called PSX, can be applied in one coat directly over the inorganic zinc primer with no need for a mid-coat. Therefore, it offers reduced application time and labor for general structural steel applications. Also, the product has long-term durability and is excellent for the most severe environments.

One of these products, PSX-700, designed for exceptional weatherability, corrosion control and long-lasting protection, is intended for such uses as bridges and marine structures, industrial plants, tanks, piping and transportation vehicles, including boats and barges. Early versions of the product were applied and evaluated at Kennedy Space Center's Beach Corrosion Test Site, and the data generated were used in its final version.





*A protective coating for the high temperatures generated by the Space Shuttle is used for other products in Earth's severe environments.*

Another product, PSX-738, is designed to withstand twice as much continuous heat as conventional heat-resistant coatings (more than 2,000 degrees Fahrenheit). This product is capable of protecting both carbon steel and stainless steel, even under insulation.

A new application of the PSX technology, which uses a custom-modified silicone intermediate, is a polysiloxane-phenolic resin for firewater piping systems in marine and offshore environments. The pipe can survive fire and deliver pressurized water where it is needed at the critical moment. These noncorrosive pipes replace steel pipes in high-pressure, high-heat and wet and dry deluge systems on ships and oil platforms.

NASA needed coatings that could protect the launch pad structures from the temperatures and acids generated by the blast of the Space Shuttle's rocket engines. The coating had to remain intact and insulate the launch pad so that its steel would not heat above 150 degrees Fahrenheit and buckle. Also, NASA wanted a sprayable coating that would cope for long periods with the heat, humidity and ultraviolet attack of the intense Florida sunlight at Kennedy Space Center.

For the NASA assignment, Ameron created an extra-high-temperature-resistant formulation of its engineered Siloxane® PSX chemistry, employing an inorganic silicon-oxygen structure stronger and more reliable than the carbon-based structure in organic polymers. The coating has been successfully

applied to the launch pads for the Boeing Delta rocket at Cape Canaveral Air Force Base and to other launch pads at the Kennedy Space Center/Cape Canaveral complex. ✱

For more information, contact Lewis Parrish at Kennedy Space Center.

☎ 407/867-6373, ✉ [ParrishLM@kscgws00.ksc.nasa.gov](mailto:ParrishLM@kscgws00.ksc.nasa.gov) Please mention you read about it in *Innovation*.

## NASA Strikes With Real-Time Lightning Detection System

**T**HE WORLD'S LARGEST LIGHTNING DETECTION manufacturer is working to upgrade and commercialize the technology used to detect and warn Space Shuttle workers that lightning is on its way. NASA's three-dimensional Lightning Detection and Ranging (LDAR) system, used in Kennedy Space Center's current lightning mapping system, can pinpoint the location and altitude of in-cloud and cloud-to-cloud lightning by measuring the exact arrival times of electromagnetic pulses.

Global Atmospheric, Inc. (GAI), of Tucson, Arizona, and NASA see many potential markets for these specialized technologies, including a broad array of industries, segments of the electric utility market, the aviation community, commercial rocket launches, recreation, construction, atmospheric research and meteorology. GAI is the largest manufacturer and system integrator of lightning detection and location equipment and services in the world. Products range from simple, single-sensor devices used to monitor local and regional lightning phenomena to fully deployed national networks that measure a full range of lightning parameters, providing data to a wide variety of users.

Under a nonreimbursable Space Act Agreement with GAI, NASA is developing a Very Short Base Line (VSBL) prototype system that will be evaluated as an enhancement to the LDAR system. New LDAR display products will also be developed that improve the presentation of the collected data.

GAI Senior Systems Engineer Claude Ceccon said that GAI is contributing its expertise and resources to improve the location accuracy, small signal detection and flexibility of LDAR using modular designs. GAI

## TECHNOLOGY TRANSFER



*The Shuttle is protected from lightning strikes with the help of an 80-foot fiberglass lightning mast atop the Fixed Service Structure that provides access to the orbiter.*

plans to develop—and offer for commercial sale—one or more lightning locating systems based on the LDAR technology.

LDAR was originally designed by NASA to protect Kennedy Space Center equipment and Space Shuttle workers who are responsible for handling, processing, launching and recovering the Shuttle and its associated payloads. Lightning warnings are frequent during Kennedy's 75-thunderstorm annual average and work stoppages that can affect launch schedules.

NASA then developed its volumetric lightning mapping system to minimize unnecessary warnings with accurate warnings to maximize productivity without sacrificing safety. The existence and the volumetric extent of the lightning hazard are defined by data from Kennedy's center-wide, seven-antenna network, which detects very high-frequency radiation to map the extent of lightning. Projections of the lightning in near real time vary from one second to two minutes.

Research is also under way concerning future space-based lightning detection and the reporting of lightning flashes in real time. LDAR data can be used to verify the correct operations of those systems by providing valuable *ground truth* information. This capability will give weather forecasters the ability to more readily evaluate threats from lightning, thunderstorm intensity and growth, as well as storm dissipation throughout the United States. ✨

For more information, contact Lewis Parrish at Kennedy Space Center.

📞 407/867-6373, ✉️ [ParrilM@kscgws00.ksc.nasa.gov](mailto:ParrilM@kscgws00.ksc.nasa.gov) Please mention you read about it in *Innovation*.

### NASA GRANTS HELP COLLEGES AND UNIVERSITIES

A total of 20 minority universities and colleges have received grants from NASA's Office of Equal Opportunity Programs to encourage students to enroll in college mathematics, science, engineering and technology disciplines and to increase the number of certified teachers in these areas. Eleven universities received grants to collaborate with NASA and local school districts, to provide informal educational opportunities that will enhance the numbers and percentage of students enrolled in mathematics and science college preparatory courses.

Precollege Awards for Excellence in Mathematics, Science, Engineering, and Technology (PACE/MSET) grants were awarded to California State University at Dominguez Hills, California State University at Northridge, the College of Santa Fe in New Mexico, Delaware State University, Jarvis Christian College in Texas, Lehman College in New York, New Mexico State University, Pasadena City College in California, Trenholm State Technical College in Alabama, Tuskegee University in Alabama and the University of Texas at Brownsville. Each PACE/MSET university will receive up to \$100,000 per year for the three years of the grant, based on performance and the availability of funds under the program.

Nine minority colleges received grants to develop teacher education and curricula integrating content from NASA missions. The results from these awards will serve as a model for other colleges and universities. It is hoped that the awards will help increase the numbers and percentage of state-certified mathematics, science, technology or geography teachers employed in "hard-to-staff" elementary, middle and secondary schools.

The nine universities selected to receive a Minority University Mathematics, Science and Technology Awards for Teacher and Curriculum Enhancement Program (MASTAP) grant include Bowie State University in Maryland, California State University at Dominguez Hills, City University of New York—Medgar Evers College, Florida International University, Heritage College in Washington State, Jackson State University in Mississippi, Mississippi Valley State University, South Carolina State University and Xavier University of Louisiana. Each MASTAP grant award recipient will receive up to \$200,000 per year for the three years of the grant, based on performance and availability of funds under the program. ✨

For more information, contact Sonja Alexander at NASA Headquarters. 📞 202/358-1761, ✉️ [sonja.alexander@hq.nasa.gov](mailto:sonja.alexander@hq.nasa.gov) Please mention you read about it in *Innovation*.



# NASA, College to Advance Virtual Reality

A SPACE ACT AGREEMENT SIGNED BETWEEN NASA's Marshall Space Flight Center in Huntsville, Alabama, and Calhoun Community College in Decatur, Alabama, is establishing a cooperative effort to advance the current knowledge base and development of virtual reality and visualization skills and examine emerging technologies in that area.

Marshall's technical facilities and accrued expertise in the virtual reality and visualization skills field, coupled with similar facilities, interests and capabilities at the college, will advance the infusion of federally developed technologies into the public and private sectors and facilitate the development of new products. This will provide greater employment opportunities and enhance prosperity regionally and nationwide.

The partnership's goals are to advance human-machine interfaces and collaboration and to encourage interactive design and simulation techniques through the design and conduct of research and development projects in the area of virtual reality and visualization technologies. The work will seek to identify a common core of skills for visualization technicians and researchers in multimedia applications, virtual reality, image processing, visualization equipment application, geographical information systems application, illustration, two- and three-dimensional CAD/CAM modeling, simulation and remote sensing.

The agreement identifies specific skills for both Marshall and Calhoun Community College. Calhoun will establish working relationships and identify opportunities with Marshall to facilitate the transfer of NASA's virtual reality technologies to the public and private sectors through government grants, educational projects and specific tasks. The college will develop virtual reality and visualization educational projects based on technical performance requirements identified by Marshall and will provide test subjects for the evaluation of virtual reality research technologies and visualization applications.

Calhoun and Marshall will cooperate in developing laboratory applications for virtual reality and human-machine interface visualization research through the use of the college's existing and planned virtual reality facilities and capabilities. With input from Marshall scientists and engineers, selected topics and projects will be incorporated into Calhoun's curriculum, as



*Marshall Space Flight Center will share its virtual reality research, facilities and personnel with an education partner to infuse emerging technologies into both the public and private sectors.*

appropriate, permitting them to be used later in Marshall's virtual reality and visualization activities.

Marshall agreed to keep Calhoun informed of new virtual reality and visualization technologies as they are developed by NASA and its contractors. Whenever possible, these will be made available for the development and enhancement of virtual reality and visualization technologies and applications at Calhoun.

Marshall scientists and engineers will advise and support Calhoun in defining laboratory hardware and software environments as well as educational/skill domains for the development of virtual reality and visualization educational programs and projects. Marshall will also provide Calhoun's faculty and students with access to the center's virtual reality and visualization facilities and personnel, whenever possible, for cooperative research and development of virtual reality applications and skills development studies. ✨

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For more information, contact Steven R. Jones at Marshall Space Flight Center.

☎ 256/544-4373, 📠 256/544-3151, ✉ [steve.jones@msfc.nasa.gov](mailto:steve.jones@msfc.nasa.gov)

Or contact Dr. Sue Mitchell at Calhoun Community College. ☎ 256/306-2655,

✉ [sue@calhoun.cc.al.us](mailto:sue@calhoun.cc.al.us) Please mention you read about it in *Innovation*.

# ADVANCED TECHNOLOGIES

## NASA Bridges the Gap

NASA'S PRINCIPAL RESEARCH AND DEVELOPMENT center for education technologies is its Classroom of the Future™ (COTF) program. By providing technology-based tools and resources to K–12 schools nationwide, the COTF is able to bridge the gap between America's classrooms and the expertise developed by NASA's scientists over the last 40 years.

Students are challenged to solve problems from technology-based materials that are first developed and researched by the COTF. This is just one of many NASA-related programs located in the Erma Ora Byrd Center for Educational Technologies™ in Wheeling, West Virginia.

Supported by a cooperative agreement between NASA's Education Division at NASA Headquarters and Wheeling Jesuit University, the COTF's efforts are supported by a NASA Educator Resource Center and a Challenger Learning Center® in a unique educational facility that also has video capabilities for videoconferencing, Internet video streaming, production, editing and broadcasting NASA Television via satellite.

The COTF web site (<http://www.cotf.edu>) highlights technology activities, such as workshops, news and events, CD-ROMs, the 21st Century Teacher Initiative and related technology programs, including the following:

- **BioBLAST® (Better Learning through Adventure, Simulation, and Technology)** is a multimedia curriculum supplement for high school biology classes, consistent with the National Science Education Standards. Adventure-simulation software with a futuristic, problem-solving scenario is used to send student teams to a lunar research facility to show high school students what it takes to live and work in a space environment, using an inquiry approach. Students design their own bioregenerative life support system (BLISS) using the BaBS (Build a BLISS System) simulator, an integrated modeling system developed at the COTF, and they conduct real scientific research using hands-on laboratory investigations and computer simulations. BioBLAST®'s virtual reality interface gives students access to Internet-based telecommunications resources, to current NASA Advanced Life Support Research (ALS)

program data and to NASA scientists currently involved in ALS research. Visit <http://www.cotf.edu/BioBLAST>

- **Astronomy Village® 1: Investigating the Universe** is a CD-ROM-based multimedia program with lessons to engage ninth and tenth grade students in scientific inquiry, learning about stars and stellar evolution and using NASA resources and data. The program's interface is based on the village-like appearance of major observatories on mountain tops. Students use an image processing program, an image browser and various simulation programs. Visit <http://www.cotf.edu/AV/av1.html>
- **Astronomy Village® 2: Investigating the Solar System** is a multimedia CD-ROM designed to complement and extend the science curricula for the fifth through seventh grades, funded by a grant from the National Science Foundation. This innovative approach to solar system astronomy is based on the award-winning high school product *Astronomy Village: Investigating the Universe*. This new CD-ROM is being developed and classroom-tested during 1998–1999. Visit <http://www.cet.edu/av2/>
- **Exploring the Environment™ (ETE)** is a series of interdisciplinary, problem-based learning modules that help students become environmentally aware, teaching them to consider and understand the impact of their actions on Earth. Using environmental Earth science course modules accessible over the Internet, the project engages student teams in addressing real-world problems related to weather, population growth, biodiversity, land-use patterns, volcanoes, water pollution and global warming. Students learn information technology skills as well as collect, analyze, generate and transmit information using computers. They e-mail their findings to other ETE schools and contact scientists for answers to questions. They search the Internet for information and use word-processing software or hypertext mark-up language (html) to report on their approach to a problem. Visit <http://www.cotf.edu/ete/main.html> ✱

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For more information, contact Nitin Naik, President of the Center for Educational Technologies at Wheeling Jesuit University. ☎ 304/243-2388, ☎ 304/243-2497, ✉ [nitin@cotf.edu](mailto:nitin@cotf.edu) Please mention you read about it in *Innovation*.

## Tune in to NASA to Learn Technologies

**N**ASA'S LEARNING TECHNOLOGIES CHANNEL (LTC) is a multidimensional web experience. E-mail, chat rooms, audio, video, text transcription, synchronized graphics and sometimes NASA Television (NTV) are used to bring forth workshops, lectures, seminars, courses and live world events.

Both the LTC and NTV provide interactive, educational experiences and agency information for educators, students, web visitors, the general public and the news media. These interactive live programs


allow viewers to electronically search the NASA centers and laboratories or any domain where scientists, astronauts and researchers are using cutting-edge aerospace technology.

The LTC makes available on the Internet interactive audio/video sessions about NASA. Students and educators get the opportunity to participate in science and outreach programs in the classroom, going behind the scenes and chatting with scientists. For more information and a full listing of exciting LTC events, visit LTC, located at Ames Research Center, Moffett Field, California, at <http://www.quest.arc.nasa.gov/ltc/index.html>

NTV broadcasts various LTC special programs. Between the scheduled LTC live events, NTV provides real-time coverage of NASA activities and missions, resource video to the news media and educational programming to teachers, students and the general public.

Free to registered educational institutions, the programming has a three-hour span—Video (News) File, NASA Gallery and Educational File—starting at noon Eastern Time and reappearing three more times throughout the day. The Education File, a schedule of programming designed specifically for students and teachers, airs at 2:00 p.m. Eastern

Time and is replayed at 5:00 p.m., 8:00 p.m., 11:00 p.m. and 2 a.m.; it includes *NASA...On the Cutting Edge*, a series of live shows. The NASA Gallery is a look at the early years of NASA, as well as replays of more recent events. It airs weekdays at 1:00 p.m. Eastern Time and is replayed at 4:00 p.m., 7:00 p.m., 10:00 p.m. and 1:00 a.m.

NTV is broadcast on the GE-2 satellite, transponder 9C, C-band, located at 85 degrees West longitude. The frequency is 3880.0 MHz. Polarization is vertical, and audio is monaural at 6.8 MHz. To view the comprehensive NTV Education File schedule, visit <http://www.hq.nasa.gov/ntv/> 

For more information, visit <http://education.nasa.gov> Please mention that you read about it in *Innovation*.

## NASA Shares Knowledge Through the Learning Technologies Project

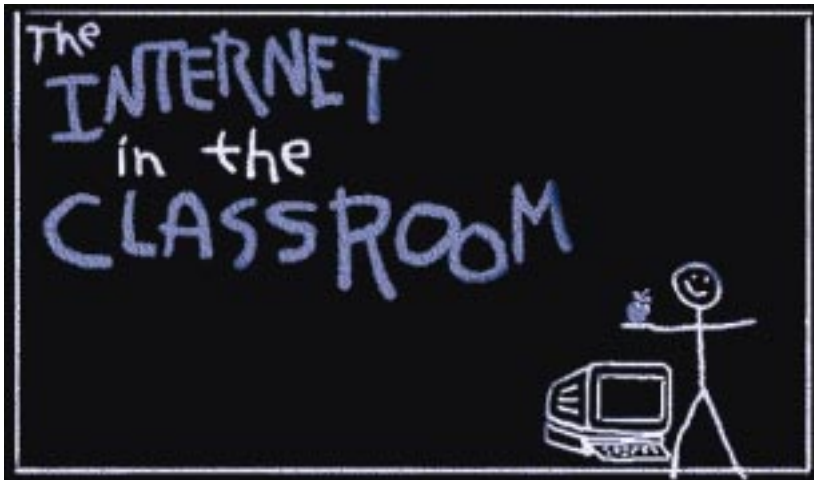
**P**PROMOTING THE GROWTH OF A NATIONAL information infrastructure using the vast amount of information acquired by NASA since its creation is the goal of the agency's Learning Technologies Project (LTP). This abundant suite of Internet projects helps teachers and students explore NASA resources and learn about NASA missions.



LTP provides on-line resources and activities from a number of disciplines, including remote access to a telescope over the Internet, software tools to manage the Internet in the classroom and a simulation to teach aerodynamics basics.

"Sharing NASA" on-line—interactive projects available from LTP's Quest server—brings the opportunity to communicate with NASA scientists and researchers and to experience the excitement of science as it is happening. Through Quest, home of





NASA's K-12 Internet Initiative, teachers can interact with other schools already on-line, explore "links" to other NASA educational resources and access information about educational grants. Students learn that science is real in the everyday world, not something done in laboratories only. Visit <http://www.quest.arc.nasa.gov/interactive>

LTP is broken down into five sectors that implement on-line resources and databases to provide an accessible foundation for educating teachers and students and to encourage teachers to further integrate this knowledge into the classroom. The five categories, accessible via the Internet, are K-12 Outreach Centers, K-14 Aeronautics Projects, Remote Sensing Public Access Center (RSPAC), Digital Library Technology Projects (DLT) and Special Projects.

LTP's Special Projects are designed to encourage the development of innovative applications of Earth and space science remote-sensing data. By stimulating broad public use, via the Internet, of the databases maintained by NASA and other agencies, the program encourages schools, businesses and citizens to access and use Earth and space science data.

LTP is a component of the High Performance Computing and Communications (HPCC) program, a government campaign that supports accelerating the development, application and transfer of high-performance technologies to the U.S. engineering and science communities. Visit <http://www.learn.ivv.nasa.gov> ✱

For more information, visit <http://education.nasa.gov> Please mention that you read about it in *Innovation*.

## Students Participate in Wright Studies

While NASA engineers are studying how wind flows around a full-scale model of the 1903 Wright Flyer, hundreds of classrooms are getting NASA wind tunnel test data about the model in almost real time via the Internet at NASA's educational web site, Wright Flyer Online, at <http://quest.arc.nasa.gov/aero/wright>

The on-line educational project, one of several online offerings from NASA's Quest Project (at <http://quest.arc.nasa.gov>) continues through the end of the 1998-99 school year. Students are able to interact with NASA experts, project staff and other classrooms through the Internet. A teachers' guide for the fifth through twelfth grades is available to educators and the general public on the web site.

The project includes many clear goals and objectives, allowing students to have fun while



*Students accessed wind tunnel data in real time via the Internet while the Wright Flyer replica underwent tests, mounted in NASA Ames Research Center's 40-foot by 80-foot wind tunnel.*

learning about current aeronautics and history of the Wright Brothers and early flight. Many activities, including games, puzzles and contests, are on-line to prepare students for the wind tunnel tests, including chat sessions with Ames engineers, pictures of the airplane model and an e-mail question-answer service.

## STUDENTS BACK TO SCHOOL WITH NASA

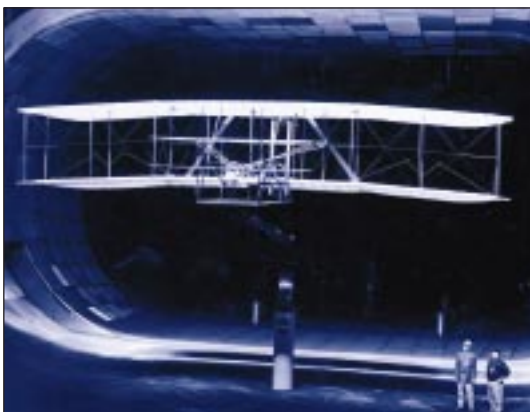
NASA has donated more than 36,000 excess computer items with an original cost of \$75 million to public, private and parochial schools serving students in prekindergarten through twelfth grade. This is part of NASA's commitment to increasing student interest in mathematics, science and technology.

Students at Kramer Middle School in Washington, D.C., demonstrated to NASA Administrator Daniel S. Goldin how NASA-donated computers have been used in their classroom. Working with the federal Computers for Learning program, established by Vice President Al Gore in 1997, federal agencies can now streamline the transfer of excess computer equipment to those U.S. schools with the greatest need. The Computers for Learning program is part of President Clinton's Education Technology Initiative.

"Vice President Gore's program gives deserving schools greater access to NASA's excess computer equipment," Goldin said. "These computers, what I call 'tools of the future,' will help ensure America's children have the skills they need to succeed in the information-intensive 21st century."

A web site, [www.computers.fed.gov](http://www.computers.fed.gov), funded by the U.S. Department of Energy, makes it even quicker and easier for U.S. schools and educational nonprofit organizations to request and obtain free equipment, including shipping by private companies. A toll-free Computers for Learning hotline (888/362-7870) is available from 1:00 to 5:00 p.m., EDT, Monday through Friday. ✱

For more information, visit [www.computers.fed.gov](http://www.computers.fed.gov) or contact David Melton at NASA Headquarters. ☎ 202/358-2302, ✉ [David.Melton@hq.nasa.gov](mailto:David.Melton@hq.nasa.gov) Please mention you read about it in *Innovation*.



*The Ames wind tunnel tests will ensure that a yet-to-be-built replica of the Wright Flyer can be flown safely on the historic flight's 100th anniversary in 2003.*

In March, the testing of a model of the first aircraft to make a successful powered and piloted flight began in the world's largest wind tunnel complex at NASA's Ames Research Center, Moffett Field, California. The tests are being conducted to ensure that a yet-to-be-built replica can be flown safely by a pilot at the same speed and altitude on December 17, 2003, the 100th anniversary of Orville and Wilbur Wright's historic flight.

"The Wright Brothers did not have access to such a modern, computerized wind tunnel," said Susan Lee, Aero Design Team Online project manager at Ames. "So, through these wind tunnel tests, engineers will document the flight characteristics of the first real airplane."

Engineers want to improve the Wright Flyer's design to increase the replica's reliability by studying the test model's stability, control and handling at speeds up to 30 miles per hour in the 40-foot by 80-foot wind tunnel at Ames. The test results will be used to compile a historically accurate aerodynamic database of the Wright Flyer.

"NASA is here as a resource for the public and to inspire young people. This project seeks to educate and inspire youth; it's much more than dollars and cents," said Pete Zell, wind tunnel test manager at Ames. "I can't think of anything as exciting as using modern technology to test a replica of the biplane that Orville and Wilbur Wright flew for the first time ever in 1903 at Kitty Hawk." ✱

For more information, contact Susan Lee at Ames Research Center. ☎ 650/856-0466, ✉ [slee@mail.arc.nasa.gov](mailto:slee@mail.arc.nasa.gov) Please mention that you read about it in *Innovation*.

# AEROSPACE TECHNOLOGY DEVELOPMENT

## Aviation Gets a Lift

**I**N THE NOT-TOO-DISTANT FUTURE, THE AVERAGE person could take to the sky in small, safe, affordable and easy-to-fly personal aircraft, traveling four times the speed of today's cars. NASA has selected a team of seven industry partners to help develop the "highway in the sky" system, a key element of the government-industry effort to revitalize general aviation in the United States.

With this system, pilots will follow a preprogrammed destination on a "virtual highway" in the sky, drawn on a highly intuitive, low-cost flat panel display. As the primary flight display of the future, it will displace decades-old "steam gauge" instrumentation.

In addition to transforming cockpits, the technology developed by the team will redefine the relationship between pilots and air traffic control and fundamentally change the way future general aviation pilots fly. This technology is expected to significantly increase freedom, safety and ease-of-flying by providing pilots with affordable, direct access to information needed for future "free-flight" air traffic control systems.

Pilots will have the ability to safely determine their routes, speeds and proximity to dangerous

PILOTS WILL HAVE THE ABILITY TO SAFELY  
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weather, terrain and other airplanes. This display system and other equipment will provide intuitive situational awareness and enough information for a pilot to perform safely, with reduced workload, in nearly all weather conditions. A multifunction display of position navigation, terrain map, weather and air traffic information is expected, in addition to digital (datalink) radios to send and receive flight data. A solid-state attitude and heading reference system will replace gyroscopes.

The team will work toward the year 2001 to complete hardware and software development and flight certification of this totally new concept for presenting critical, flight-path guidance information to the pilot. This will be the first attempt to certify such a system using affordable commercial "off-the-shelf" computer technology in aircraft.

Development costs will be shared equally between NASA and the industry team, with both contributing approximately \$3 million. Team members are Avidyne Corporation of Lexington, Massachusetts, AvroTec Inc. of Portland, Oregon, Lancair of Redmond, Oregon, Raytheon Aircraft of Wichita, Kansas, Rockwell Collins of Cedar Rapids, Iowa, Seagull Technologies of Los Gatos, California, and AlliedSignal of Olathe, Kansas.



*The "highway in the sky" system is a key element of the government-industry effort to revitalize general aviation in the United States. The cockpit display system will include a computer-drawn highway that the pilot follows to a preprogrammed destination.*



*The Advanced Civil Transport Simulator (ACTS) is a futuristic aircraft cockpit simulator designed to provide full-mission capabilities for researching issues that will affect future transport aircraft flight stations and crews.*



AvroTec is the team lead, and Avidyne is technical project manager.

The Advanced General Aviation Transport Experiments (AGATE) consortium, consisting of more than 70 members from industry, universities, the Federal Aviation Administration and other government agencies, is fostering the "highway in the sky" system. NASA created AGATE in 1994 to develop affordable new technology, industry standards and certification methods for next-generation single-pilot, four- to six-seat, near all-weather light airplanes.

AGATE and the General Aviation Propulsion engine development program are providing industry partners with technologies leading to a small aircraft transportation system in the early 21st century. These efforts support the national general aviation "roadmap" goal to "enable doorstep-to-destination travel at four times highway speeds to virtually all of the nation's suburban, rural and remote communities." ✱

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For more information, contact Keith Henry at Langley Research Center.

☎ 757/864-6120, ✉ [h.k.henry@larc.nasa.gov](mailto:h.k.henry@larc.nasa.gov) Please mention you read about it in *Innovation*.

## X-33 Metallic Heat Shield Ready for Flight

**T**HE DEVELOPMENT OF A LOW-COST SPACE plane took a step forward last month when one of three technologies essential to its success was declared "ready for flight." Designed for NASA's X-33 technology demonstrator, the rugged, metallic thermal protection panels, developed and built by team member BFGoodrich Aerospace/Aerostructures Group in Chula Vista, California, are expected to dramatically cut maintenance time and costs associated with more fragile thermal tile systems.

Because the metallic panels on the lower surfaces of the X-33 make up the vehicle's windward, aerodynamic structural shell, the system also will obtain significant weight savings over traditional thermal systems, while being much more durable and waterproof. The metallic thermal protection panels passed an intensive test series that included sessions in high-speed, high-temperature wind tunnels. The panels also were strapped to the bottom of a NASA F-15 aircraft and flight-tested at nearly one and a half times the speed of sound.

## NASA AMES HOSTS BATTLE OF THE ROBOTS

**S**tudent-made robots "clashed" in February at NASA's Ames Research Center, Moffett Field, California, in a western regional competition to inspire more students to become engineers. Organizers say the overall goal of the robot competition is to allow students to interact with engineers so that the young people can see the connection between classroom instruction and the real world.

"In the next two decades, NASA will engage in bold new missions of exploration of our star system with robots," said Mark Leon, manager of the competition. "In order to accomplish these robotic missions, we will need talented people to build the next generation of robots. That fact, plus NASA's dedication to education, is our motivation for helping students to participate in this competition."

Each year, the group develops the competition by supplying "a problem" and a kit of parts to student teams. During the competition, robots "battled" for two-minute rounds in an arena setting, attracting participants from at least 27 high schools in the eight-state western region, including California, Arizona and Texas. NASA works cooperatively with a nonprofit group called "For Inspiration and Recognition of Science and Technology" (FIRST), Manchester, New Hampshire, which organizes the contests.

Students and their advisors designed and constructed remote-control robots in six weeks using identical kits of material. Advisors are often professional engineers from private industry, government and universities. The regional finals took place across the country, and winners may compete at the national finals in April in Orlando, Florida. To learn about the robotic contests, visit the Ames Learning Technology Project web site at <http://quest.arc.nasa.gov/firstrobots> ✱

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For more information, visit the Ames Learning Technology Project web site above or contact Mark Leon at Ames Research Center.

☎ 650/604-6498, ✉ [mleon@mail.arc.nasa.gov](mailto:mleon@mail.arc.nasa.gov) Please mention you read about it in *Innovation*.

## AEROSPACE TECHNOLOGY DEVELOPMENT



*The F-15 is used as a testbed aircraft to validate the durability of the X-33 thermal protection system materials.*

Additional laboratory tests duplicated the environment that the X-33's outer skin will encounter while flying roughly 60 miles high at more than 13 times the speed of sound. Also, a thermal panel fit test successfully demonstrated the ease of panel installation and removal.

The thermal protection system combines aircraft and space plane design, using easy-to-maintain metallic panels placed over insulating material. As the X-33 flies through the upper atmosphere, the panels will protect the vehicle from aerodynamic stress and temperatures comparable to those a reusable launch vehicle would encounter while reentering Earth's atmosphere. Tests have verified that the metallic thermal protection system will protect vehicles from temperatures near 1,800 degrees Fahrenheit. Most thermal protection systems flying today consist of a fragile insulation material glued to the outside of the vehicle's shell. The X-33's protection panels do not require an aeroshell, resulting in a significant saving in weight

over the Shuttle system. The more durable metallic panels and rigid blankets serve as the X-33 vehicle's aerodynamic structural shell, fastened to a composite standoff skeletal structure.

The Shuttle thermal system must be refurbished after each flight, using an estimated 17,000, or more, work-hours. The goal of the reusable launch vehicles, such as the X-33, is to reduce the refurbishment time so that the vehicle can fly within a few days. Mechanical attachments can allow thermal protection system panels to be quickly and easily removed and replaced to meet this goal. Also, metallic thermal panels last longer and do not require waterproofing, as does the Shuttle. The inherent ductility of metallic materials offers a potentially more robust outer surface. Its geometric parameters offer the opportunity to modify the design to accommodate different conditions.

"By developing and proving these systems, we're creating the ability to build space planes that eventually will fly to orbit, return for servicing and launch again as often as today's commercial airplanes make scheduled flights," said Dan Dumbacher, NASA X-33 deputy program manager, assigned to Marshall Space Flight Center in Huntsville, Alabama. Marshall is NASA's lead center for developing future space transportation systems.

Work continues on the two remaining technologies important for low-cost space access—an efficient propulsion system ideally suited to power a lifting body and, more importantly, lightweight-yet-strong composite cryogenic fuel tanks and structures to minimize vehicle weight. The X-33 program is now entering a phase of intense testing and qualification of the vehicle's components.

The X-33 is a half-scale technology demonstrator of a full-scale, commercially developed reusable launch vehicle that Lockheed Martin has named "VentureStar," planned for development after the turn of the century. Through airplane-like operations and a single-stage-to-orbit design, a full-scale reusable launch vehicle could dramatically reduce the cost of putting payloads into space.

Although suborbital, the X-33 will fly high enough and fast enough to encounter conditions similar to those experienced on an orbital flight path. This will help fully prove its systems and performance. ✨

*Closeup of F-15B Flight Test Fixture with X-33 thermal protection systems.*



For more information, contact Dom Amatore at Marshall Space Flight Center. ☎ 256/544-0031. Please mention you read about it in *Innovation*.

# Students Soar With Experiments in NASA Aircraft

**F**OR THE THIRD CONSECUTIVE YEAR, 48 TEAMS of college students from around the country investigated a variety of scientific disciplines from inside a NASA aircraft in a student program originating from NASA's Johnson Space Center in Houston, Texas. A second group of 48 teams is scheduled for August 1999.

NASA's 1999 Reduced Gravity Student Flight Opportunities Program, funded by NASA and administered by the Texas Space Grant Consortium in Austin, Texas, took about 96 teams of undergraduate students aloft in a KC-135A aircraft. The goal of the students was to study the effects of microgravity on various scientific experiments.

The NASA KC-135A flies over the Gulf of Mexico. During each two- to three-hour flight, the aircraft maneuvers through a series of about 40 steep climbs and descents, called parabolas. Depending on the precise trajectory flown by the plane, the passengers and their experiments can experience about 25 seconds of a zero-gravity environment on each parabola. The KC-135A aircraft is used to introduce astronauts to the feeling of microgravity, test hardware and experiments destined for space flight and evaluate medical protocols that may be used in space.

During the student campaign, teams of up to four students and a professional journalist fly aboard the aircraft to conduct and evaluate their experiments. The journalist documents and reports on the students' efforts. A supervising professor and a student ground support team remain at Ellington Field near Johnson to support their flying counterparts.

Months before flying on the KC-135A, known as the "weightless wonder," the students must identify, develop and test their experiments. The experiments are critiqued for scientific merit and are

reviewed extensively for safety by NASA experts prior to the flight.

During the first week of their two-week visit to Houston, program participants receive pre-flight training and assemble and test their experiment packages. The students fly with their experiments during the second week, adjusting equipment as needed and conducting postflight debriefings and reviews.

Each team also is required to develop a program for sharing the results of its experiment with teachers, students and the general public following the conclusion of the flight campaign. The participants must analyze their data, prepare applicable education and information materials and submit final postflight reports.

A list of the selected teams and additional information about the program can be found at <http://www.tsgc.utexas.edu/floa/n/>. The Texas Space Grant Consortium is a component of the Space

Grant College and Fellowship Program, which is administered by NASA. ✨

For more information, contact Burke Fort, Project Director of NASA's Reduced Gravity Student Flight Opportunities Program. ☎ 512/471-3585, [fort@csr.utexas.edu](mailto:fort@csr.utexas.edu) Please mention you read about it in *Innovation*.

*College students fly over the Gulf of Mexico aboard this KC-135A aircraft to conduct and study microgravity research.*

...THE PASSENGERS AND THEIR  
EXPERIMENTS CAN EXPERIENCE ABOUT  
25 SECONDS OF A ZERO-GRAVITY  
ENVIRONMENT ON EACH PARABOLA.





## Campbell Named Laboratory Director of the Year

**T**HE FEDERAL LABORATORY CONSORTIUM (FLC) has named NASA's Glenn Research Center Director Donald J. Campbell the 1998 Laboratory Director of the Year for Technology Transfer. The award recognizes Campbell's successful efforts to broaden the commercialization of Glenn's technologies. Campbell will receive the award on April 21, 1999, at the organization's 25th anniversary national meeting in Salt Lake City, Utah.

In the last five years, at least 20 new products have been created through Glenn-developed tech-

"I ACCEPT THE AWARD ON BEHALF OF THE CENTER'S EMPLOYEES WHO WORK SO DILIGENTLY IN TRANSFERRING THEIR TECHNOLOGIES FOR COMMERCIAL APPLICATIONS."

nologies. Under Campbell's leadership, the Lewis Incubator for Technology was established to help entrepreneurs and start-up companies gain financial and marketing assistance as they commercialize NASA-developed technologies. In addition, the newly created Garrett Morgan Commercialization Initiative helps increase the competitiveness of small businesses and small disadvantaged businesses in Ohio and the Great Lakes region through the use of NASA technologies.

Campbell also has been instrumental in providing a hands-on educational experience to African-American and Hispanic students each year through the Science, Engineering, Mathematics and Aerospace Academy (SEMAA). The program, a collaborative effort between Glenn and Cuyahoga

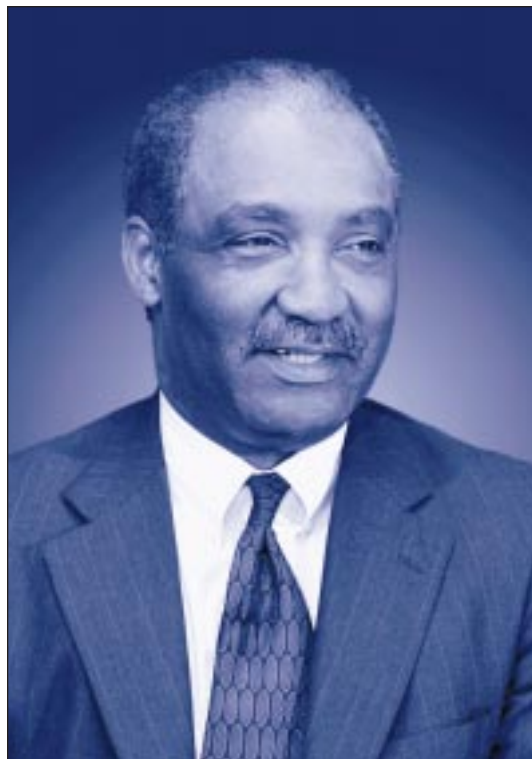
Community College, Cleveland, Ohio, has proven to be extremely successful. Since its inception, SEMAA has been replicated twice, with plans for seven additional sites in major cities.

"I'm honored to have been chosen to receive this award," said Campbell. "I accept the award on behalf of the center's employees who work so diligently in transferring their technologies for commercial applications."

"I'm very happy to be able to recognize Don Campbell's contributions to technology transfer and support for the FLC," said Dr. Jagdish Mathur, principal scientist at Marconi Aerospace and chair of the FLC's National Advisory Group. "Don is an outstanding and dedicated individual who has demonstrated leadership and personal commitment to work with American industry and the community for economic development and growth. His efforts have made a difference."

The award is presented annually to honor laboratory directors who have made exemplary contributions to the overall enhancement of technology transfer for economic development.

FLC members include more than 600 of the largest federal government research laboratories and centers, representing 16 federal departments and agencies. The mission of the FLC is to promote



*Donald J. Campbell, Director of NASA's Glenn Research Center, has been named the 1998 Laboratory Director of the Year for Technology Transfer by the Federal Laboratory Consortium.*

and facilitate the rapid movement of federal laboratory research results and technologies into the mainstream U.S. economy.

Campbell is a native of Lima, Ohio. He earned a bachelor's degree at Ohio Northern University and a master's degree at Ohio State University, both in mechanical engineering. He holds honorary doctorate degrees from Wilberforce University and Ohio Northern University. He is a member of the Tau Beta Pi Engineering Honorary Society. ❄

For more information, contact Laurie Stauber at Glenn Research Center.

☎ 216/433-2820 📠 216/433-2555, ✉ [Stauber@grc.nasa.gov](mailto:Stauber@grc.nasa.gov)

Please mention you read about it in *Innovation*.

## Solar System Technologies Explored

**T**HE SMALL BUSINESS INNOVATION RESEARCH (SBIR) program at the Jet Propulsion Laboratory (JPL) is supporting a number of small companies to develop new technologies intended for enhanced solar system exploration. It is hoped that some day these technologies may result in new products and discoveries that will enhance our lives.

In Situ Exploration and Sample Return is a new SBIR technology development initiative to help collect the vast amount of information required before scientists can provide a reasonable description of the nature of our solar system or be able to tell whether life previously existed on Mars or Jupiter's moon, Europa. Recent discoveries that indicate the possibility of ancient life on Mars and possible underground bodies of water on Europa have given a new sense of adventure and urgency to this work, according to Byron Jackson, program support manager at JPL.

The goals are significant overall cost and risk reduction of future science missions while reducing the need for ground control operations and communications facilities. The miniaturization of multiple spacecraft and landers, rather than a single large spacecraft, will enable future science missions to explore the planets, moons and asteroids of our solar system.



The first demonstration of new technology will occur as part of the Mars Surveyor Lander mission launched in January. Two microprobes have been designed to piggyback on the mission, utilizing its communications system to relay information on weather and soil chemistry back to Earth. Each probe weighs only two kilograms (about 4.5 pounds) and consists of a penetrator instrument package and an aeroshell to protect it during its descent to the surface of Mars. Upon impact, the penetrator will pierce the aeroshell and bury itself in the Martian soil, where it will perform in situ soil experiments.

Technologies supported by SBIR contracts in the area of in situ exploration include: lasers operating at appropriate ultraviolet and visible wavelengths to enable nondestructive nucleic and amino acid detection with a miniature detector; a micro balloon probe for aerial photography based on a self-inflating zero-pressure (the point

*Launch pad workers prepare the Mars Global Surveyor spacecraft before it lofted into space in January 1999. Technologies being developed to continue the Surveyor mission are showing commercial promise.*



*Technologies with potential commercial applications are being developed for explorations beyond the Mars Surveyor mission.*

that limits pressure as a system's temperature approaches absolute zero) polyethylene balloon; and a control strategy for robotic systems that is calibration free, robust, highly accurate and suitable for sampling and retrieval tasks. These represent only a few of the innovations the NASA SBIR program is supporting that will enhance our ability to explore the solar system. ✨

For more information, contact Byron Jackson at the Jet Propulsion Laboratory.

☎ 818/354-1246, 📠 818/354-2385, ✉ [Byron.L.Jackson@jpl.nasa.gov](mailto:Byron.L.Jackson@jpl.nasa.gov)

Please mention you read about it in *Innovation*.

## NASA Commercializing Web Training System

**A** FLORIDA/NASA BUSINESS INCUBATION CENTER client is commercializing NASA's Web Interactive Training (WIT) software technology under a nonexclusive copyright license agreement with Kennedy Space Center. Under the agreement, the

company will use the Internet with multimedia software that provides quality training to NASA remote users.

The Florida/NASA Business Incubation Center in Brevard County serves the location needs and provides assistance to early-stage technology-based businesses and entrepreneurs by offering affordable space, sharing office equipment and services (including offsite technology-based clients), access to NASA technology, technical assistance and business training. For more information, visit <http://technology.ksc.nasa.gov/FNBIC>

The WIT technology uses multiplatform interactive media to deliver training to users more effectively and efficiently. The primary delivery medium is the World Wide Web. A typical WIT course incorporates text, graphics, audio, video, animation and testing.

Merrimac Interactive Media Corporation, based in Marlton, New Jersey, is an offsite client that runs a development laboratory in Cocoa, Florida. The company specializes in computer-based learning applications, electronic performance support systems, independent software development and learning network delivery systems.

Merrimac's David Metcalf initiated the development of the WIT system while he was working for the Kennedy Space Center engineering support contractor, I-NET, Inc., in Kennedy's Multimedia Laboratory. I-NET assigned the copyright to NASA.

Metcalf explained that "Merrimac intends to commercialize the WIT system and continue to advance the capabilities of the system as new techniques and technologies for accelerating learning through technology become available." New applications include using the latest in streaming video and push technologies, synchronous instructional communications aids (videoconferencing and live bulletin boards) and team-based learning using web communications tools.

Several WIT-based training courses were developed for Kennedy Space Center's Safety and Mission Assurance Directorate, according to NASA engineer Paul Mogan. The first phase of the project was the conversion of an existing course on Nondestructive Evaluation (NDE) and the creation of a new course on Statistical Process Control.



## NASA SELECTS SMALL BUSINESS PROJECTS

**N**ASA has selected 125 research proposals for negotiation of Phase II contract awards for the Small Business Innovation Research (SBIR) program. The selected projects, which have a total value of approximately \$73 million, will be conducted by 113 small, high-technology firms located in 26 states.

The goals of this NASA program are to stimulate technological innovation, increase the use of small business (including women-owned and disadvantaged firms) in meeting federal research and development needs and increase private-sector commercialization as a result of federally funded research. Phase II continues the development of the most promising Phase I projects. A total of 312 proposals was submitted by SBIR contractors completing Phase I projects. These proposals were evaluated to determine that they meet SBIR Phase I objectives and are feasible research innovations for addressing agency needs. Selection criteria include technical merit and innovation, Phase I results, value to NASA, commercial potential and company capabilities. Funding for Phase II contracts may be up to \$600,000 for a two-year performance period.

The NASA SBIR Program Management Office is located at NASA's Goddard Space Flight Center, Greenbelt, Maryland, with executive oversight by NASA's Office of Aero-Space Technology at NASA Headquarters, Washington, D.C. Individual SBIR projects are managed by NASA's field centers. ✱

For more information, contact Mike Braukus at NASA Headquarters. ☎ 202/358-1979, 📠 202/358-3750, ✉ [mbraukus@mail.hq.nasa.gov](mailto:mbraukus@mail.hq.nasa.gov) Please mention you read about it in *Innovation*.

NASA's objective is to efficiently and effectively train a large base of NASA workers using state-of-the-art technologies delivered over the Internet through a web browser interface. Kennedy's Multimedia Laboratory has developed four training courses that incorporate interactive simulation modules, a random test genera-



tor with a testing database and interactive feedback, and the seamless integration of electronic performance support system components into the online training system

Computer-based learning, also known as computer-based or interactive training, is an economical solution to the problem with which organizations are faced. The WIT system (and all interactive training) targets the individual's method of learning by consistently presenting information in ways people most effectively learn—by seeing, hearing and doing. The user hears the narrator highlighting and reinforcing concepts, while the interactive components allow the user to participate in the presentation.

The benefits are reduced training costs and associated travel and time-off task costs. Metcalf added that the training is available in the office on a personal computer 24 hours a day, seven days a week, for user convenience and follow-up job performance support after the training is completed. ✱

For more information, contact Lewis Parrish at Kennedy Space Center. ☎ 407/867-6373, ✉ [ParriLM@kscgws00.ksc.nasa.gov](mailto:ParriLM@kscgws00.ksc.nasa.gov) Please mention you read about it in *Innovation*.

*A NASA/Florida Business Incubation Center company is commercializing the Web Interactive Training (WIT) software. Here, a Kennedy Space Center launch team trains with simulated flight and ground configurations to prepare for 1998's STS-95 launch.*



## Hot NASA Technologies

### Liquid-Crystal Interferometer

The John H. Glenn Research Center seeks partnerships to transfer a new liquid-crystal interferometer, proven to measure optical wavefronts of transparent objects. The liquid-crystal interferometer provides low-cost, small-volume, data reduction and full field measurement options. These measurements permit the determination of temperature, density, chemical composition or thickness distributions in transparent solids, gases or liquids. This device can also be used to measure the shape of highly reflective objects, such as mirrors. The instrument has a compact, robust design and optical phase-stepping capability for qualitative data analysis. The result is a compact, simple-to-align, environmentally insensitive interferometer capable of accurately measuring optical wavefronts. This instrument is at least two orders of magnitude less sensitive than conventional interferometers. The interferometer is constructed from a liquid-crystal layer that provides object-beam phase control and an embedded microsphere that locally generates a reference beam. The potential commercialization avenues include glass or plastic inspection, optical testing, remote temperature measurement, chemical mixing measurement and fluids studies. ✨

For more information, contact Larry Viterna at Glenn Research Center.  
 ☎ 216/433-3484, ☎ 216/433-5012, ✉ Larry.A.Viterna@grc.nasa.gov  
 Please mention you read about it in *Innovation*.

### Implantable Biotelemetry System

Ames Research Center is currently seeking partnerships to develop commercial applications for the Implantable Biotelemetry System for preterm labor and fetal monitoring. The goal is to create one pill-sized transmitter, small enough to be introduced into the uterus through a 10-millimeter trocar, that measures all four fetal physiological parameters: pressure, temperature, pH and heart rate. The pill transmitter's compactness, longevity and durability are substantial advancements because the transmitter allows a pediatric surgeon, for the first time, to monitor intra-uterine pressure changes in real time and to get immediate information on contraction frequency and intensity. With the advances, built on the 1993 Fetal Treatment Center/Sensors 2000! adaptation of NASA's Implantable Biotelemetry System, the pill has potential uses other than for fetus surgery. A prototype of the transmitter has been built on a printed circuit board using surface-mount

components and is currently being tested in pregnant sheep. The final "pill" version's circuits are identical to the printed circuit board; however, the pill uses chip-on-board technology to drastically reduce the size of the printed circuit board from 38 by 28 millimeters to 22 by 8 millimeters. The portability of the system makes it easily adaptable to any hospital setting and ideal for use in a home-based monitoring environment, which opens a new field of applications in fetal monitoring. Because the pill transmitters are small enough to be swallowed, they can easily provide information on stomach acid without the need for surgery. Intestinal pressure changes could be monitored as well. Future pill versions could measure electrocardiograms, blood gas (such as carbon dioxide) and blood glucose, as well as ions such as potassium, calcium and sodium. ✨

For more information, contact Denise Helwig at Ames Research Center.  
 ☎ 650/604-4490, ☎ 650/604-1592, ✉ dhelwig@mail.arc.nasa.gov  
 Please mention you read about it in *Innovation*.

### Millimeter Wave/Microwave Ablation

Johnson Space Center is seeking industrial partnerships to continue the testing of the millimeter wave/microwave ablation and to license this technology for nonaerospace applications. The millimeter wave/microwave ablation is for the nonsurgical repair of diseased coronary arteries by interventional cardiologists during coronary catheterization. Potentially safer than balloon angioplasty and other prior forms, the device delivers millimeter/microwave energy by way of a catheter to precise locations of the coronary arteries. The device selectively targets and heats atherosclerotic lesions. It can be used to melt away fatty deposits of atherosclerosis and does not scar the blood vessel, thus preventing restenosis (a condition in which platelets and white blood cells go where the blood vessel was damaged). It is very noninvasive; it can be used as a preventative measure and can precede the implantation of a stent and allow multiple tasks to be performed in one catheterization. The device consists of a millimeter/microwave power source, a catheter transmission line in the form of a waveguide or coaxial cable and an antenna/radiator located at the distal end of the catheter. The potential commercial use, with a forecasted multi-billion-dollar market worldwide, is noninvasive treatment for atherosclerosis. ✨

For more information, contact the Technology Transfer and Commercialization Office at Johnson Space Center. ☎ 281/483-1749, ☎ 281/244-8452, ✉ commercialization@jsc.nasa.gov Please mention you read about it in *Innovation*.

**Technology Opportunity Showcase** highlights some unique technologies that NASA has developed and which we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in *Innovation*.



## NASA Field Centers

### Ames Research Center

Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

#### Carolina Blake (Acting)

Ames Research Center  
Moffett Field, California 94035-1000  
650/604-0893  
[cblake@mail.arc.nasa.gov](mailto:cblake@mail.arc.nasa.gov)

### Dryden Flight Research Center

Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

#### Eugene (Lee) Duke

Dryden Flight Research Center  
Edwards, California 93523-0273  
805/258-3802  
[lee.duke@dfrc.nasa.gov](mailto:lee.duke@dfrc.nasa.gov)

### Glenn Research Center

Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High Temperature Materials Research, Microgravity Science and Technology and Instrumentation Control Systems.

#### Larry Viterna

Glenn Research Center  
Cleveland, Ohio 44135  
216/433-3484  
[Larry.A.Viterna@grc.nasa.gov](mailto:Larry.A.Viterna@grc.nasa.gov)

### Goddard Space Flight Center

Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

#### George Alcorn

Goddard Space Flight Center  
Greenbelt, Maryland 20771  
301/286-5810  
[george.e.alcorn.1@gsfc.nasa.gov](mailto:george.e.alcorn.1@gsfc.nasa.gov)

### Jet Propulsion Laboratory

Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics, and Autonomous Systems.

#### Merle McKenzie

Jet Propulsion Laboratory  
Pasadena, California 91109  
818/354-2577  
[merle.mckenzie@jpl.nasa.gov](mailto:merle.mckenzie@jpl.nasa.gov)

### Johnson Space Center

Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations

#### Henry (Hank) Davis

Johnson Space Center  
Houston, Texas 77058  
281/483-0474  
[henry.l.davis@jsc.nasa.gov](mailto:henry.l.davis@jsc.nasa.gov)

### Kennedy Space Center

Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

#### Gale Allen

Kennedy Space Center  
Kennedy Space Center,  
Florida 32899  
407/867-6226  
[gale.allen-1@kmail.ksc.nasa.gov](mailto:gale.allen-1@kmail.ksc.nasa.gov)

### Langley Research Center

Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

#### Joe Heyman

Langley Research Center  
Hampton, Virginia 23681-0001  
757/864-6005  
[j.s.heyman@larc.nasa.gov](mailto:j.s.heyman@larc.nasa.gov)

### Marshall Space Flight Center

Selected technological strengths are Materials, Manufacturing, Non-destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

#### Sally Little

Marshall Space Flight Center  
Huntsville, Alabama 35812  
256/544-4266  
[sally.little@msfc.nasa.gov](mailto:sally.little@msfc.nasa.gov)

### Stennis Space Center

Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Noninvasive Instrumentation.

#### Kirk Sharp

Stennis Space Center  
Stennis Space Center, Mississippi 39529-6000  
228/688-1914  
[kirk.sharp@ssc.nasa.gov](mailto:kirk.sharp@ssc.nasa.gov)

## NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

#### Joseph C. Boeddeker

**Ames Technology Commercialization Center**  
San Jose, CA  
408/557-6789

#### Lyn Stabler (Acting)

**Mississippi Enterprise for Technology**  
Stennis Space Center, MS  
228/688-3144

#### Wayne P. Zeman

**Lewis Incubator for Technology**  
Cleveland, OH  
216/586-3888

#### Thomas G. Rainey

**Florida/NASA Business Incubation Center**  
Titusville, FL  
407/383-5200

#### Judy Johncox

**University of Houston/NASA Technology Center**  
Houston, TX  
713/743-0451

#### Kirk Wiles

**Business Technology Development Center**  
Huntsville, AL  
256/704-6000

#### Kathleen Weiss

**Maryland Economic Development Corp.**  
Greenbelt, MD  
800/541-8549

#### Van Garner

**California State Polytechnic University-Pomona**  
Pomona, CA  
909/869-2276

#### Martin Kaszubowski

**Hampton Roads Technology Incubator**  
Hampton, VA  
757/865-2140

## Small Business Programs

#### Carl Ray

NASA Headquarters  
**Small Business Innovation Research Program (SBIR/STTR)**  
202/358-4652  
[cray@hq.nasa.gov](mailto:cray@hq.nasa.gov)

#### Paul Mexcur

**Goddard Space Flight Center Small Business Technology Transfer (SBIR/STTR)**  
301/286-8888  
[paul.mexcur@pop700.gsfc.nasa.gov](mailto:paul.mexcur@pop700.gsfc.nasa.gov)

## NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTC nearest you, call 800/642-2872.

#### Ken Dozier

**Far West Technology Transfer Center**  
University of Southern California  
213/743-2353

#### Dr. William Gasko

**Center for Technology Commercialization**  
508/870-0042

#### J. Ronald Thornton

**Southern Technology Applications Center**  
University of Florida  
352/294-7822

#### Gary F. Sera

**Mid-Continent Technology Transfer Center**  
Texas A&M University  
409/845-8762

#### Lani S. Hummel

**Mid-Atlantic Technology Applications Center**  
University of Pittsburgh  
412/383-2500

#### Christopher Coburn

**Great Lakes Industrial Technology Center**  
Battelle Memorial Institute  
440/734-0094

#### Joseph P. Allen

**National Technology Transfer Center**  
Wheeling Jesuit University  
800/678-6882

#### Doris Rouse

**Research Triangle Institute Technology Applications Team**  
Research Triangle Park, NC  
919/541-6980

## NASA ON-LINE

Go to **NASA's Commercial Technology Network (CTN)** on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.



## MOVING FORWARD

### Events

The National Science Foundation, in association with the Department of Defense and the Small Business Administration, is sponsoring the *Fall National Small Business Innovation Research (SBIR) Conference*, November 21–23, 1999, at the Las Vegas Hilton, Las Vegas, Nevada. Sessions will provide basic information on the SBIR and Small Business Technology Transfer (STTR) programs for small business attendees interested in learning more about this federal government grant program. Phase II and III participants will be able to participate in special interactive track sessions designed to help them as they move toward commercialization. Other program sessions will address grants and contracts, business planning, proposal preparation and other topics of interest to small businesses.

Program managers and representatives from participating agencies will provide insight into how to work with their respective agencies and answer your own special questions during the one-on-one opportunities. For more specific program details and registration information as it becomes available, call 360/683-5742, e-mail to [sbir@zyn.com](mailto:sbir@zyn.com), or visit [www.zyn.com/sbir/index.html](http://www.zyn.com/sbir/index.html)

**INNOVEST '99** is being held May 11–12, 1999, at the Cleveland Marriott, Cleveland, Ohio. This 15th annual regional conference unites venture capital and private investment with companies seeking financing. Attendees will meet investors, corporate and professional service executives and technology transfer professionals from across the nation. Contact Teresa Kraus, Enterprise Development, Inc., in Cleveland, by calling 216/229-9445, ext. 122, or e-mailing at [tkraus@edinc.org](mailto:tkraus@edinc.org) ✱



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